Glaucoma screening clinic in general practice: prevalence of occult disease, and resource implications

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SUMMARY

Background. *Previous studies have shown that for every known case of glaucoma there is another case of occult disease. Most cases of glaucoma are detected by optometrists.*

Aim. *This study set out to determine the prevalence of occult glaucoma in a practice population and assess the likely resource implications of introducing a glaucoma screening programme into a general practice setting.*

Method. *The 1153 patients registered with one practice in Leicester who were aged 55–69 years on 1 January 1992 and who were not known to have glaucoma prior to screening were invited to a screening clinic. Prior to screening there were 11 known cases of glaucoma in this age group. Screening was carried out by a practice nurse. Patients who failed the screening tests were referred according to the study protocol to the ophthalmology department of the Leicester Royal Infirmary and examined by one ophthalmologist. The number of cases of occult glaucoma and other eye disease detected, the cost per case screened and case detected, and the number of referrals generated were evaluated.*

Results. *Nine hundred and fifty people (82%) accepted the invitation and attended for glaucoma screening. Of those screened 115 (12%) were referred for ophthalmic assessment. Glaucoma was confirmed in 14 of the referred patients (12%) while a further 15 (13%) were found to have ocular hypertension. All but one of those people diagnosed as having glaucoma recalled having been examined by their optician within the last five years; for 50% the period was less than two years. Nineteen of the patients referred (17%) had other ocular pathology detected by the ophthalmologist and no abnormality was detected in 65 patients referred (57%). The estimated cost to the practice (excluding hospital outpatient costs) per case screened using the study protocol was £6 and the cost per case detected was £408.*

Conclusion. *Glaucoma screening may be successfully undertaken in a general practice setting by non-ophthalmically trained staff who have received tuition in the use of the equipment. It is well received by the population served but the capital cost of equipment is likely to be too high for most practices to afford. The reaffirmation of at least one occult case of glaucoma for every known case is particularly alarming in the absence of a national screening programme and the asymptomatic course of this treatable, blinding disease. Closer cooperation between general practitioners and optometrists will be the practical way ahead for most practices.*

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Introduction

GLAUCOMA is a potentially blinding disease which for most patients is insidious in its onset and course.[1-4] Most cases are detected by routine optometric screening[5-10] or present symptomatically in the late stages of the disease when much irreversible loss of visual field has already occurred.[11] The late detection of cases is one of the main features identified as a poor prognostic indicator.[12-14] It is therefore of particular concern that several studies have demonstrated that 50% of glaucoma in the population is occult.[15-18]

Since the abolition of generally available free sight testing in April 1989 there has been debate as to the effect of this on the number of sight tests performed[19] and therefore on the detection of cases of glaucoma.[20] Non-contact tonometry by non-ophthalmically trained staff in a general practice setting has been proposed as an effective first line screening test for glaucoma.[18,21,22] It has also been suggested as a method of case detection that would be cheaper for the taxpayer/government than screening by optometrists.[23,24]

The aims of this study were to measure the prevalence of occult glaucoma and ocular hypertension within a defined population, and to identify the resource implications of introducing a glaucoma screening programme into a general practice setting.

Method

Screening was carried out in a four partner general practice in an urban area on the outskirts of Leicester with a list size of 8300 people. None of the partners had worked in the field of ophthalmology since graduation.

Since the highest referral rate to the Leicester Royal Infirmary ophthalmic clinic of patients with suspected glaucoma was in the 70–79 years age group (unpublished data), screening was started in the 55–69 years age band. All 1153 patients in this age group registered with the practice and not known to have glaucoma were invited by letter, in five year age bands, to attend for glaucoma screening at the general practice surgery. Prior to screening there were 11 known cases of glaucoma in this age band. One further case was detected by an optician and the diagnosis subsequently confirmed by an ophthalmologist during the course of the study.

The screening programme began in January 1992 and was completed for this age group on June 1993. Screening was conducted by one practice nurse. It included a lifestyle history, blood pressure measurement, visual acuity recording, four measurements of intraocular pressure for each eye using a Keeler air-puff tonometer (mean for each eye displayed automatically), and visual field testing using a Humphrey automated perimeter with the Armaly screening programme. In the early stages Damato oculokinetic perimetry was also carried out. The practice nurse had no previous ophthalmic training and had received training in the use of the non-contact tonometer and visual field analyser by the standard training visits of company representatives to the

practice. Patients were screened at 20 minute intervals, 10 being seen in each clinic.

The screening protocol adopted resulted from adapting that proposed by Vernon and colleagues[18] following a small pilot programme (the first 40 patients tested). An abnormal field was defined as three or more adjacent relative or absolute field defects in the same points on two attempts. If the intraocular pressure was greater than 22 mmHg in both eyes patients were referred. If the pressure was greater than 22 mmHg in one eye and patients had an abnormal field in either eye they were referred, but if both eyes had normal fields the measurement of intraocular pressure was repeated in one month when if the pressure was still greater than 22 mmHg in either eye patients were referred. If the pressure was less than 23 mmHg in both eyes but patients had an abnormal field in either eye they were referred. All patients referred to hospital were seen first by one general practitioner (A S) who explained the reason for the referral.

Patients were referred to Leicester Royal Infirmary and examined by a single ophthalmologist (J S). Here patients were assessed by slit lamp examination, Goldmann applanation tonometry and Goldmann visual field testing. This examination by the ophthalmologist was performed without knowledge of the reasons for referral applicable in any individual case.

For the purposes of this study, glaucoma was defined as the presence of raised intraocular pressure, as measured by Goldmann contact tonometry, greater than 22 mmHg with glaucomatous visual field defects, for example, paracentral scotomas, arcuate scotomas, nasal steps and temporal wedges. Ocular hypertension was defined as an intraocular pressure greater than 21 mmHg with normal visual fields. Cases of ocular hypertension were classified as low, medium or high risk according to the classification of Yablonski and colleagues based upon level of intraocular pressure and cup:disc ratio.[25]

The costs to the practice of the screening programme were calculated on the basis of the number of patients who were offered screening and the uptake rate. The nurse time needed for screening was calculated from measurements of the time needed to screen each patient and included the time required to retest patients according to the protocol. Secretarial and postage costs were included as was the capital cost of the equipment written down over five years.

Results

Of the 1153 patients, 950 attended for screening (82.4%); 453 men and 497 women.

Screening

History taking and explanation took a mean of five minutes. Four measurements of intraocular pressure were obtained for each eye for all patients. The mean pressure for the 1900 eyes tested was 17.0 mmHg (standard deviation 4.4 mmHg). The mean pressure for all left eyes was 17.2 mmHg (SD 4.5) and for all right eyes 16.8 (SD 4.3). Intraocular pressure was always measured in the left eye first. The mean time to carry out the eight pressure readings for each patient was two minutes 30 seconds.

Ten patients (1.1%) were unable to carry out visual field testing satisfactorily owing to poor concentration, existing visual loss or difficulty with finger coordination. The mean time to carry out this test for both eyes was eight minutes, with a minimum time of six minutes 40 seconds. An additional mean of one minute was taken in explanation of the test.

The first cohort screened were aged 65–69 years and the first 253 patients in this group had oculokinetic perimetry performed as well as Humphrey visual field testing. Of the 253 patients, 64 (25.3%) had an abnormality on oculokinetic perimetry of whom only 17 (26.6%) had abnormal fields with the Humphrey field analyser, the other 47 being normal. Twenty six patients (10.3%) had difficulty understanding and reliably performing oculokinetic perimetry but only four of these had difficulty with the Humphrey test.

Seventy of the 950 patients (7.4%) required re-screening at one month in accordance with the protocol owing to raised intraocular pressure having been detected in one eye during their initial examination.

Referrals and diagnoses

Of those screened 115 (12.1%) were referred; a referral rate of 66.5 per 1000 patients per year. This represents a 259% increase in referrals as the practice's previous referral rate to the department of ophthalmology for the same age group had been 18.5 per 1000 population per year.

The ophthalmologist's diagnoses for the referred cases are shown in Table 1 together with the reason for the referral. Of the 115 patients referred, 14 people (12.2%) were diagnosed as having glaucoma (1.5% of those screened). Of these, three had normal pressures when screened and were detected because of their field abnormalities. All three of these cases showed raised pressures when seen in the eye clinic. Eight of the 14 patients with glaucoma had intraocular pressures of 25 mmHg or less on screening. Eight of those found to have glaucoma were in the 55–59 years age group and two of these had advanced field loss. Prior to the screening programme there were only two known cases of glaucoma in this age group. Table 2 shows optician attendance as recalled by the population attending for screening, by family history of glaucoma together with distribution of cases of glaucoma. The highest rate of glaucoma detection was in those with a first degree family history of glaucoma who had

Table 1. Ophthalmologist's diagnoses, by reason for referral.

	No. of patients referred					
Diagnosis	Raised IOP in both eyes (screening field normal)	Raised IOP in both eyes and screening field abnormal	Raised IOP in one eye and screening field abnormal	Raised IOP in one eye on two occasions (screening field normal)	Normal IOP and screening field abnormal	Total
Glaucoma	3	3	1	4	3	14
Ocular hypertension	7	2	1	5	0	15
Other ocular abnormality	5	0	0	1	13	19
Failed to attend	1	0	0	1	0	2
Normal	33	3	4	16	9	65
Total	49	8	6	27	25	115

IOP = intraocular pressure.

Table 2. Optician attendance, by first degree family history of glaucoma, together with distribution of cases of glaucoma.

Time since last visit to optician	No. of patients[a] (no. with diagnosis of glaucoma)	
	Family history of glaucoma	No family history of glaucoma
Never visited	0 (0)	21 (0)
>5 years	3 (0)	112 (1)
2–5 years	7 (0)	286 (6)
<2 years	26 (1)	494 (6)
Total	36 (1)	913 (13)

[a]Data missing for one patient.

seen an optician within the last two years (3.8 cases per 100 population screened).

Fifteen people (13.0%) were diagnosed as having ocular hypertension, 10 being low and five medium risk. A further 19 patients (16.5%) had other ocular non-glaucomatous abnormalities. Seven had disc anomalies: tilted discs (three), gross peripapillary atrophy (three) and disc drusen (one); four had retinal anomalies: old branch retinal arterial emboli (two), severe retinitis pigmentosa (one) and retinal coloboma (defect in the formation of the optic cup causing an enlarged blind spot) (one); three had other conditions: cataracts (two) and possible intraocular pressure asymmetry (one); and five were under investigation owing to non-glaucomatous visual field loss.

In 65 cases (56.5%) no abnormality was detected. Two patients (1.7%) failed to keep their appointment with the ophthalmologist.

If field testing had been performed only on those people found to have raised intraocular pressures, as specified in Vernon and colleagues' protocol,[18] 90 (9.5%) of those screened would have been referred and three patients with glaucoma and one with advanced retinitis pigmentosa would have been missed.

Prevalence

The prevalence of glaucoma in the population screened was 22.3 cases per 1000 population (26/1165 = 2.23%, 95% confidence interval 1.24 to 3.22%). The prevalence of ocular hypertension was 12.9 cases per 1000 population (15/1165 = 1.29%, 95% CI 0.64 to 1.94%).

Predictive power of screening tests

The positive predictive power for intraocular pressure measurements was 12.2% (11/90) for glaucoma and 16.7% (15/90) for ocular hypertension (Table 1). Using visual field testing alone without measuring intraocular pressures would have resulted in 39 referrals of which seven were found to have glaucoma. This gives a positive predictive power for glaucoma of 17.9% for visual fields alone. The positive predictive power for glaucoma of an abnormal visual field on screening in the absence of raised intraocular pressure was 12.0% (three/25).

Costs

Table 3 shows the estimated costs involved in running the glaucoma screening programme according to the study protocol. The overall cost per case of glaucoma detected was estimated to be £572.71 (14 glaucoma cases found) representing £8.44 per case screened. These estimates include a £30.00 first consultation fee at an ophthalmic clinic for all 115 referrals generated. The cost to the practice per case screened was £6.02.

Discussion

The prevalence of glaucoma detected in the study population is in keeping with the results of previous studies.[15,26-28] Unfortunately, the results reaffirm that for every known patient with glaucoma there is another with occult disease.[15-18,29] This situation has remained unchanged for 28 years. It was surprising to find that among those screened eight of the 14 patients found to have glaucoma were in the 55–59 years age group, two of whom had advanced visual field loss.

The diagnosis of glaucoma requires an assessment of the intraocular pressure, the visual fields and the fundus. A screening programme which includes an assessment of all three factors yields the least false positives but is impracticable in the general practice setting because of the high degree of experience needed by the examiner in assessing the fundus. Currently, the majority of glaucoma case detection is by optometrists who have the equipment and the experience of disc assessment to detect glaucoma at an early stage.[5] However, 50% (seven) of the patients who were found to have glaucoma in this study claimed to have been examined by an optician within the last two years, and all but one of the other seven within two to five years. Within the screened population 520 people (55%) claimed to have visited their optometrist within the last two years and a further 293 people (31%) within the last two to five years. This would suggest that the glaucoma had been missed, not tested for or had developed in the period since optometric assessment. The reasons for this failure of case finding by optometrists may include the lack of a standard glaucoma screening protocol among optometrists; widely varying referral criteria;[29-31] patients' reluctance to pay for eye tests; and the difficulties of screening a population without a 'captive list'. General practitioners have an advantage in screening for disease in that a given population is 'captive' on the list, they have well honed administrative systems for systematically screening a population, the screening is free to the patient so encouraging attendance, and defaulters can be easily identified.

The glaucoma clinic was popular with patients. The attendance rate of 82% was high compared with 43% for the same age range at the practice's well person clinic. Vernon and colleagues found a similar attendance rate in their study of community based glaucoma screening.[18] Many patients who had not responded to invitations to attend the well person clinics in the practice were happy to attend for glaucoma screening. While attending the glaucoma screening clinic 16 patients were found to have systemic hyper-

Table 3. Estimated costs of offering all 1153 55–69 year olds glaucoma screening using the study protocol.

	Cost (£)
Practice costs (per annum)	
Practice nurse[a]	2093.00
Secretarial costs	230.00
Postage and stationery	200.00
Keeler tonometer[b]	1084.00
Humphrey visual field analyser[b]	2111.00
Total	5718.00
Cost to practice per case of glaucoma detected	408.43
Cost to practice per case screened	6.02
Hospital costs (per annum)	
Hospital ophthalmic referrals @ £30.00 each[c]	2300.00
Overall cost per case of glaucoma detected	572.71
Overall cost per case screened	8.44

[a]Grade G, 4.5 hours per week (1994, 3rd increment). [b]Costed over five years. [c]115 referrals divided by 1.5 years.

tension requiring treatment (based on repeated testing) — seven of these patients had failed to attend following invitations to a well person clinic in the previous five years.

The practice nurse found both the non-contact tonometer and the field analyser easy to learn to use and the procedure simple to explain to patients. All patients tolerated well, and completed, the eight air puffs and only 10 patients (1%) were unable to complete visual field testing. Unlike applanation tonometry used in some screening programmes[32,33] the Keeler non-contact tonometer produces a liquid crystal display readout of the intraocular pressure and so is not subject to observer errors and is easier to use. The mean of the four readings for each eye is automatically displayed. Compared with contact tonometry, non-contact tonometry also has the advantage in the general practice setting of avoiding the need for eye drops. The Humphrey field analyser produces a printout showing points of relative or absolute defect on a map depicting the visual field. Various programmes can be selected; the 72 point screening programme used in this study is sufficiently sensitive to detect relative visual defects for the purpose of screening without being too time consuming, the mean time for each eye being four minutes. Training only required two hours of instruction from the company representatives. The mean intraocular pressure (17.0 mmHg) and standard deviation (4.4 mmHg) were higher than those reported by Vernon and colleagues who also used non-contact tonometry (mean 15.0, SD 3.3).[18] The calibration of the tonometer used here was checked during the course of the study so this is unlikely to account for the difference.[34]

Although only 12% of the referrals in this study were found to have glaucoma an additional 13% had ocular hypertension requiring further follow up at the hospital or their optician and a further 17% had non-glaucomatous visual field abnormalities. Thus, 42% of referrals had a confirmed abnormality. Of the 19 patients who had non-glaucomatous visual field abnormalities one had advanced retinitis pigmentosa, two had evidence of embolic retinal damage and five were under follow up with visual field abnormalities of unknown cause. However, it is unlikely that the detection of the non-glaucomatous abnormality benefited the patient in most cases. Cervical screening programmes and the National Breast Screening Programme also produce a high false positive referral rate[35,36] but it can be argued that the anxiety generated by false positives is more acceptable when the condition screened for is life threatening, rather than related to quality of life as in glaucoma screening. The high rate of false positives produced by a non-ophthalmically trained practice nurse screening for glaucoma resulted from the strict criteria applied for referral compared with those used by optometrists where raised pressures may be ignored in the absence of corroborative disc features.[30,31] While it is possible that the patients with glaucoma discovered in this study who had recently seen an optician had been normal at the time of their optometric appointment, individual variations in optometric glaucoma screening methods and referral criteria may play a role in these cases not having been detected. Tuck and Crick have calculated that about half of all glaucomatous cases occur in those with raised intraocular pressure in the borderline range of 21–25 mmHg.[31] This is the group where screening protocols and referral criteria vary most widely among optometrists, with fewer than half carrying out visual field testing in these patients.[31] Eight of the 14 patients found to have glaucoma in this study had intraocular pressure on screening of 25 mmHg or less. It would seem advisable for general practitioners to find out what protocol their local optometrists follow for those patients found to have borderline raised pressure.

The estimate of £5718 per year (excluding the cost of hospital referrals generated by the screening programme) to a four-partner practice for an in-house screening programme using the protocol described here is likely to put glaucoma screening beyond the reach of most practices in spite of the fact that this represents only £408 per case detected or £6 per case screened. The costs of nurse time could be offset by including glaucoma screening in established well person screening clinics but the capital cost of equipment can no longer be offset by the screening clinic fee which was abolished in July 1993.

Although a contact tonometer would be cheaper to purchase than a non-contact tonometer it is a less attractive screening tool in the general practice setting as outlined above. A simple printed chart to examine the visual fields has been advocated as a cheap, alternative screening tool for visual fields.[37,38] In this study this test produced an unacceptably high percentage of abnormalities (25%), and 10% of patients had difficult understanding how to perform the test and its use was abandoned early in the study.

If widely implemented, screening programmes in general practice using a standard protocol could make a considerable impact on the number of cases of glaucoma diagnosed at an early stage and thus would save sight. However, already hard pressed hospital ophthalmic departments would be swamped by referrals. We suggest that despite the absence of a national glaucoma screening programme general practitioners can take steps to improve the detection of glaucoma among their patients without involving themselves in the expense of equipment and nurse time. This would rely on cooperation between optometrists and general practitioners to utilize the patient registers of general practice to invite patients to attend local optometrists who would follow an agreed protocol of assessment and follow up. Vernon and colleagues' algorithm[18] could be further modified to include fundal examination and the criteria for referral relaxed on borderline raised intraocular pressures if visual fields and fundal examination were normal. This would reduce false positive referrals while at the same time allowing systematic screening according to a protocol. The question of the fee charged to the patient has to be addressed although optometrists might consider the additional business generated by an increased awareness of their other services would allow the fee to be waived. If optometrists were used to provide a glaucoma screening service it would be essential that the funding for such a programme was not drawn from the hospital eye service budget as the hospital workload would be considerably increased by the referrals produced by the screening programme.

Fundholding general practices could contract out the screening procedure itself to local optometrists or to specially designated clinics within ophthalmic departments using a screening protocol. This would be similar to the National Breast Screening Programme; the letter of invitation coming from the patient's general practitioner but the screening itself carried out elsewhere.[39] Thus the 'captive list' system of general practice would be utilized in conjunction with the skills and equipment of either local optometrists or ophthalmic departments. If local hospital ophthalmic departments took up the screening role, investment in equipment and the development of the role of glaucoma technicians, who would be supervised by ophthalmologists, would be necessary to cope with the increased workload. The introduction of a glaucoma screening programme carries considerable workload implications for the local hospital eye services and more efficient ways of providing these services should be sought.

Considering the prevalence of both known and occult glaucoma and the treatable nature of this potentially blinding condition, the lack of an efficient national screening programme is a worrying scotoma in our current field of health screening. Turning a 'blind eye' to this silent loss of vision is to deprive

elderly people of the future quality of life associated with good vision.[40]

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